

FINAL REPORT

OCTOBER 1985

PREPARED FOR

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION  
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TITLE: DE-1 PHASE III EXTENDED MISSION DATA ANALYSIS OF  
DYNAMICS EXPLORER RETARDING ION MASS SPECTROMETER FLIGHT DATA

PURCHASE ORDER NO. H-78173B  
UTD ACCOUNT 24011-961

BY

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PERIOD: 25 JAN 1985 THRU 24 NOV 1985

DECEMBER 5, 1985

(NASA-CR-178704) DE-1 PHASE 3 EXTENDED  
MISSION DATA ANALYSIS OF DYNAMICS EXPLORER  
RETARDING ION MASS SPECTROMETER FLIGHT DATA  
Final Report, 25 Ja. - 24 Nov. 1985 (Texas  
Univ.) 7 p HC A02/MF A01

N86-20433

Unclas  
05439

CSCI 22A G3/12



## RIMS Final Report

During the tenure of this grant we have attempted to understand and reconcile observations of field-aligned motion of ionospheric ions at low altitudes and different pitch angle distributions of ionospheric ions at high altitudes. We have made substantial progress in this direction and, while some significant questions remain, we have reached an understanding of the degree to which data from Dynamics Explorer can elucidate some of the questions.

Our objectives have been twofold. First we wish to discover the degree to which observations made by DE-1 and DE-2 agree when taken in the same ionospheric volume. Second, we wish to understand the processes operating along a magnetic field tube connecting DE-1 and DE-2 that allow a reconciliation of the two data sets. In pursuit of our first objective we began some selected analysis of DE-1 data to produce altitude profiles of ion temperature and number density. A representative profile is shown in Figure 1. These data were prepared with the objective of comparison with DE-2 in the same volume. While the data were found to be consistent it was also found that the radial head RIMS data was unsatisfactory for this purpose. Since it was not anticipated that we would process the bulk data that is required for a systematic solution to this problem, our findings were communicated to the RIMS investigators for further action.

Our second investigation has two facets. The first to reconcile the observed occurrence of ionospheric ions at high altitudes with a point source injection in the ionosphere and subsequent  $\underline{E} \times \underline{B}$  drift. The second to reconcile the observed fluxes of ionospheric ions at high altitudes with the measured upward flux at low altitudes. Both these studies require that data be taken by DE-1 and DE-2 on the same magnetic flux tube at about the same univer-

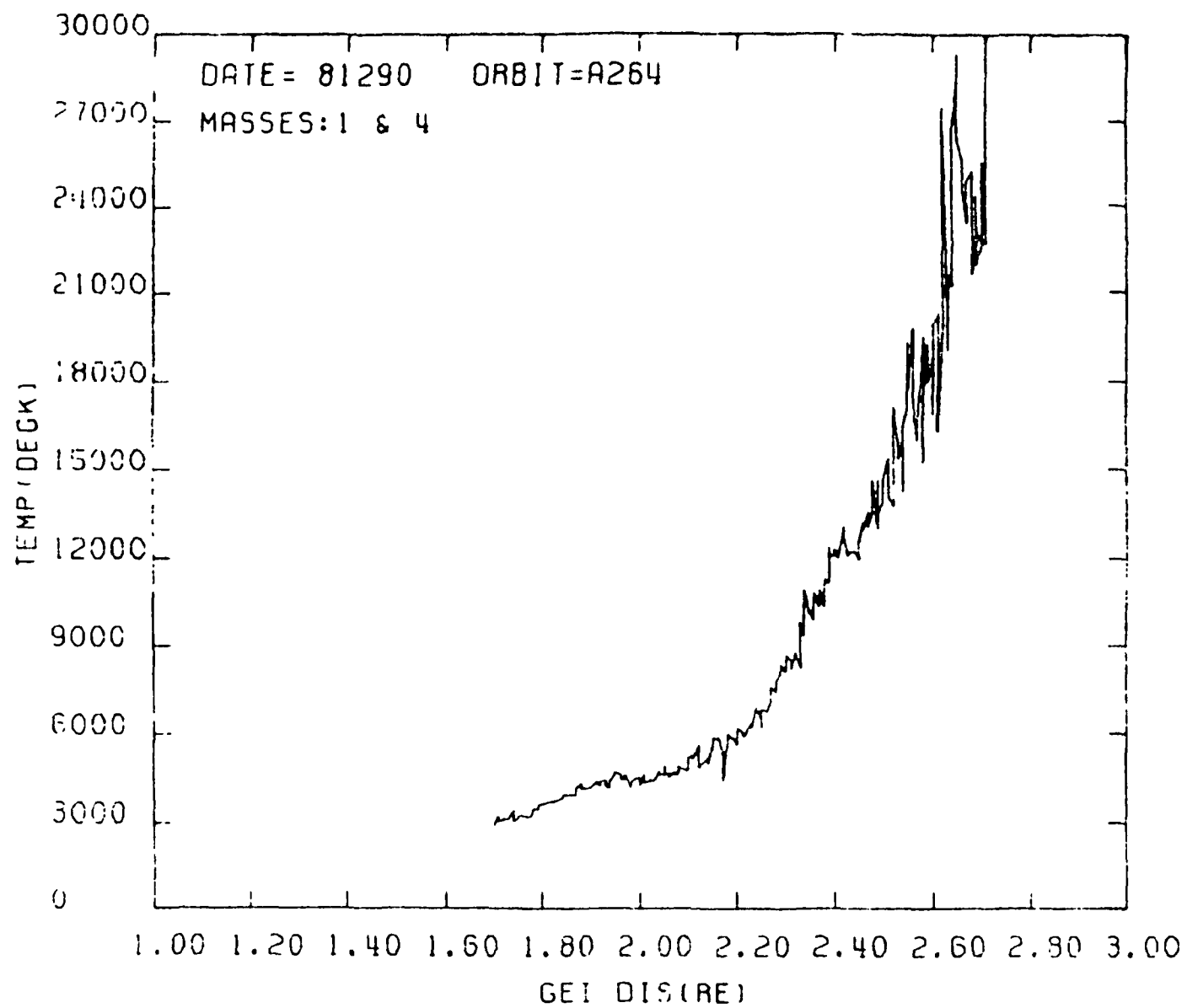


FIGURE 1

sal time. This is not a frequent occurrence, and even less frequent when the requirement for upflowing ion signatures is imposed on the data. Nevertheless some examples were found and in fact more have subsequently been found that require further analysis.

Figure 2 shows the ionospheric convection pattern deduced from DE-2 data for one particular event. The pattern is consistent with the southward interplanetary magnetic field and negative  $B_y$  prevailing at the time. Of particular importance is the fact that the antisunward flow in the dayside polar cap is directed very nearly along the satellite track from noon to midnight. Assuming that the noon-midnight plane approximately coincides with the magnetic meridian plane, then DE-1 also flies along the  $\underline{E} \times \underline{B}$  drift direction of the plasma. This circumstance allows for an interpretation of the simultaneously observed DE-1 data in terms of the field-aligned motion of ions and their perpendicular  $\underline{E} \times \underline{B}$  drift motion. Figure 3 shows that for this event DE-1 first encounters outward flowing  $H^+$  of ionospheric ions. Also a small time later, corresponding to higher latitudes in the polar cap,  $He^+$  is observed flowing away from the ionosphere. Finally at even higher latitudes  $O^+$  is observed. This displacement of the latitudes at which the ions are first observed by DE-1 can be explained by appealing to a low altitude parallel energization of the ionospheric species that provides all ions with the same energy. A field-aligned electric field would meet the requirements. The ionospheric ions then have field-aligned velocities dependent on their mass. Thus  $H^+$  with highest velocity reaches DE-1 altitudes before  $O^+$  with lower velocity. This effect combined with the antisunward motion of all ions produces the observed dispersion now called the geomagnetic mass spectrometer. At this stage an understanding of the effects of  $\underline{E} \times \underline{B}$  drift motion on the dispersion of ionospheric ions has been completed. Still outstanding is a description of the almost point

RESOLUTION IS NOW EVERY 4 POINT  
ENTER DESIRED RESOLUTION OR RETURN

DE-B ION DRIFT VELOCITIES  
MLT U ILAT NORTHERN HEMISPHERE  
DAY 82 60 UT 23:23 ORBIT 3130

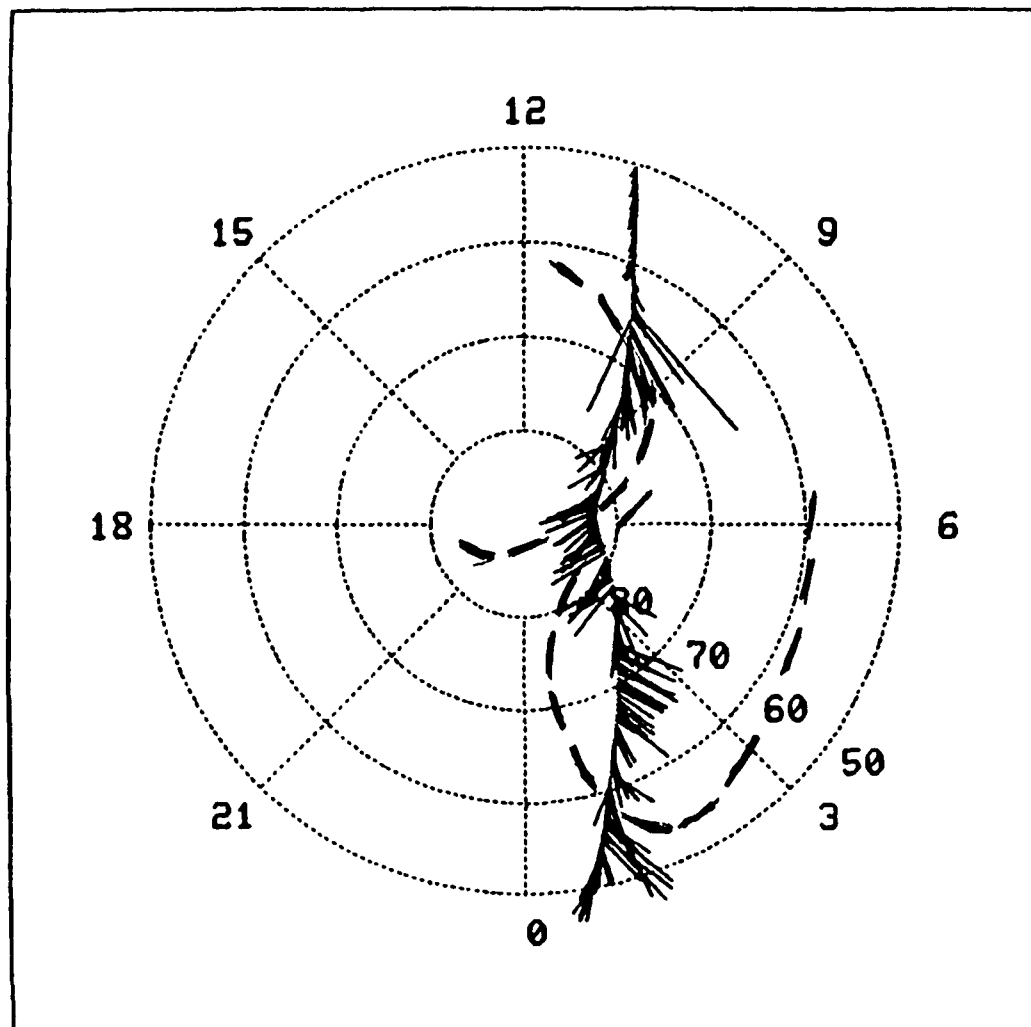


FIGURE 2

UT	09 45	10 00	10 15	10 30	10 45	hrs mns
r	3 85	4 08	4 27	4 42	4 54	R <sub>E</sub>
MLT	9 9	10 0	10 2	10 4	10 6	hrs
Λ	71 1	74 0	76 7	79 1	81 3	deg

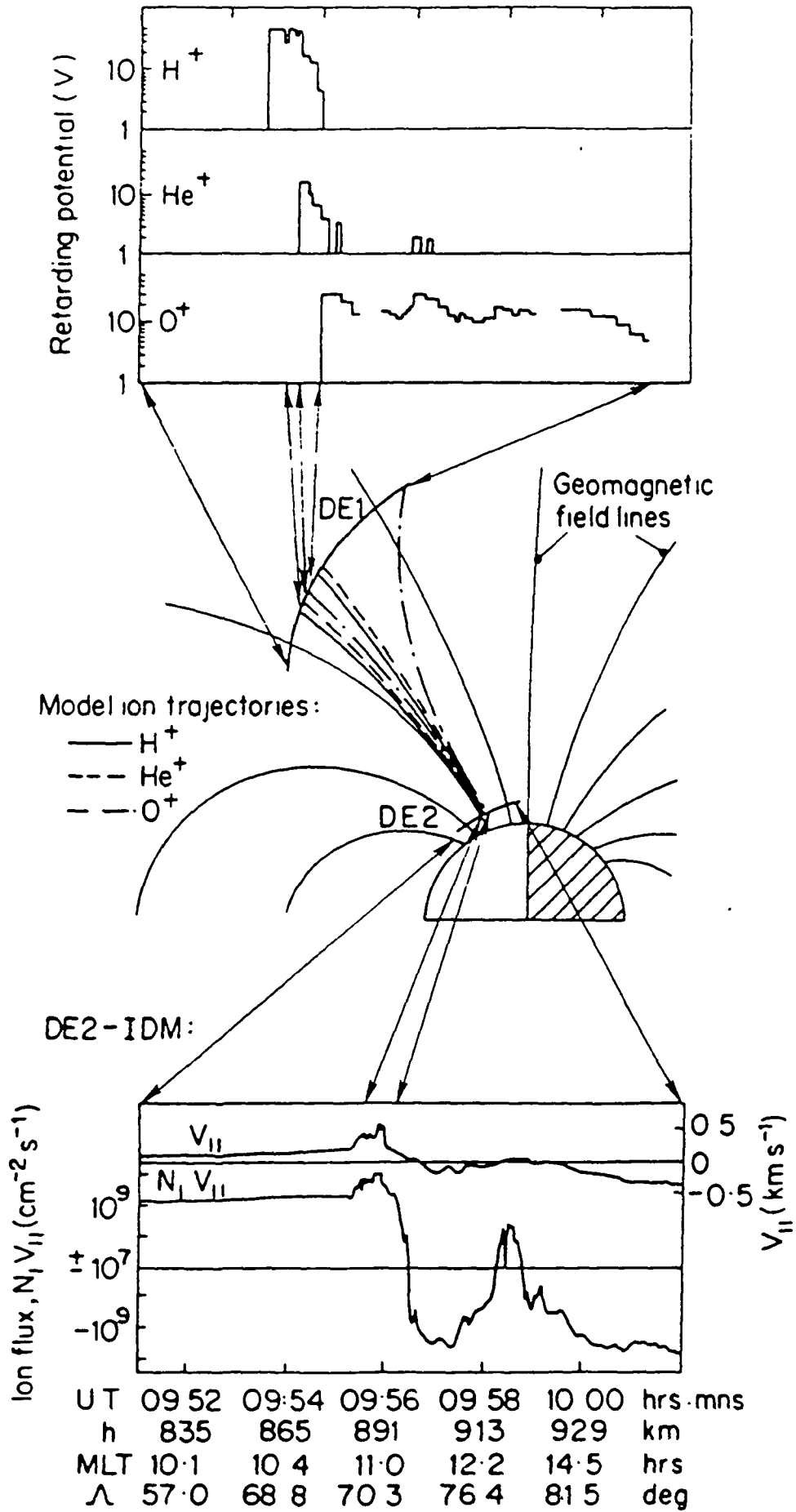


FIGURE 3

source acceleration along magnetic field lines required by the observations.

The studies supported by this grant have opened the way to future case studies of individual events in the DE-2 data and to more statistical studies of the DE-1 data. We now expect that circumstances prevailing during DE-2 observed ionospheric injection events will be described and that more theoretical modelling may reveal the processes producing the variety of pitch angle distributions observed by DE-1.